Iron-rich blood is just fine, thank you!

For decades, blood centers in the United States would not collect whole blood from donors/patients with hereditary hemochromatosis (HH), in some cases because it used to be that such units had to be labeled with the disease necessitating its removal. Since HH is treated primarily by iron depletion from phlebotomy, then phlebotomy for maintenance, this was seen as an incentive for which some people might lie about their health history and risk. It was seen as an inducement. In 2016, the FDA encoded the regulations for therapeutic phlebotomy, so it was no longer required to have a variance from the FDA to do so.

Special labeling is not required, and units may be distributed if they meet regular requirements and criteria, as long as the therapeutic phlebotomy (TP) is ordered by a physician and the phlebotomy performed without charge. Therapeutic donations are accepted in many countries but resisted in even more due to the lingering concerns about safety, cost and operational compliance. Some will accept the blood once the “maintenance phase” of iron depletion is reached, but not during the induction phase.

Authors of the paper from Australia (see references below) carried out a retrospective cohort study to compare the infectious disease risks of regular whole blood donors vs units obtained for TP. They tested all the donations from the Australian Red Cross Blood Services between January 1, 2011, and December 31, 2013. There was a yearly mean of 11,789 TP donors with a yearly mean of 107,773 donations from that group, and a yearly mean of 468,889 voluntary donors with a total of 2,584,705 total donations.

The rates of transfusion-transmissible infections in red cell units destined for component production were significantly lower in therapeutic donations compared to standard voluntary donations, 8.4 vs 21.6 per 100,000 donations. Bacterial contamination was similar, 43.0 vs 45.9 per 100,000, and post-donation illness (self-reported) was comparable. It is of note that therapeutic donors donate at a higher rate than standard volunteers, a proven, previously tested resource.

In their editorial, West and Eder carefully review the infectious risk data from TP donors in Australian study, noting that since the genetic cause of hereditary hemochromatosis was clarified in 1996, there is no cause to worry about the HH itself. This also removes the risk of such donors hiding the reason wanting to donate and leaves the donation itself with only the same risks as any other non-remunerated blood donation.

The National Institutes of Health has been running its own blood program, from donors to bedside transfusion, for years,

In the news

2–3 Iron-rich blood is just fine, thank you!
3–4 Plasma: A strategic resource
4–5 How do we monitor changes in transfusion-transmitted infections?
5 Can we “Not Transfuse” our way to enough blood?
6 Improving red blood cell utilization using clinical decision support
7 Harmful effect of platelet transfusion in acute hemorrhagic stroke due to antplatelet treatment
8 Blood and sex still matter
9 Tranexamic acid is a procoagulant; it works by inhibiting clot breakdown
10 Nationally, confusion continues with massive transfusion protocols
11 Spring is coming! What do we do about Babesia this year?
12 Update on reimbursement for platelet safety measures

Cover photo: Red Blood Cells or Erythrocytes, showing their biconcave disc shape. Visuals Unlimited, Inc.

This issue of PLUS was written by Dr. Robert (Bob) Westphal.
since 2001. HH donors comprise 7% of their donor base, but provide 11% of their allogeneic blood supply. Some centers in the U.S. have raised concerns about the “extra” logistics of running such a TP-related program for HH patients. They point out that such donors must meet the same donor criteria as everyone else, just as anyone donating blood must do for their own safety, as well. Given that all blood collection facilities and personnel have required systems for controls, quarantine, etc. there are no concerns outside of standard operating procedure except for maintaining the minimal medical reports to the prescribing physician.


Plasma: A strategic resource

Minimally invasive surgery, the use of fiberoptic endoscopy and laparoscopy and significant decreases in red cell transfusion thresholds have led to equally significant decreases in the amounts of blood collected around the world. Developed countries, which used to collect much larger volumes of blood than others, and much more than they do now, have especially noted such declines. In a recent (2016) survey in the United States, 26.8% fewer units of plasma were produced than in the previous survey.

As well as maintaining the human intravascular volume, plasma provides for the circulation and homeostasis of proteins, electrolytes, hormones and key constituents of our metabolic processes. Plasma for direct human transfusion and for plasma-derived medical products (PDMPs) such as clotting factor concentrates Factor VIII and Factor IX, immune globulins and hyperimmune globulins such as rabies, hepatitis B and RhIg are on the World Health Organization’s (WHO) list of essential medicines (essential medicines list, or EML). The importance of the EML, which includes a large number of other pharmacologic agents, stems in great part from the fact that it is used by countries with scarce healthcare resources to guide their selection of drugs/agents. In addition, a recently published randomized study (2016) showed that recombinant FVIII is about twice as likely as plasma-derived FVIII, which contains von Willebrand Factor to induce anti FVIII antibodies in previously untreated hemophilia A patients. The World Federation of Hemophilia estimates that 400,000 people are living with hemophilia, and only about 25% receive adequate therapy.

After separation of whole blood donations into components, developed countries collect more plasma than needed for direct transfusion and send the rest of it for further manufacture of PDMPs. Plasma from less developed countries is often unsuitable for either transfusion or for further manufacture and often discarded, leading to the need—and expense—to import PDMPs. Such costs cannot be borne by all but the wealthiest citizens, if available. But the need for plasma as a source material for other critical products requires the collection of source plasma, plasma from plasmapheresis and from commercial sources in the developed world.

Source plasma comes primarily from the U.S. commercial plasma industry. This plasma increased from 11,000,000 liters in 2004 to 34,000,000 liters 10 years later. Of the world’s 552 plasmapheresis centers, 80 are located in the U.S. Although U.S. plasma is critical for meeting international, as well as national, needs, reliance on any single country, or region puts PDMPs at great risk in uncertain times. Regional shortages might have a number of causes, including military conflicts, economic or political factors, transfusion-transmissible disease outbreaks, and things such as movement by suppliers to higher-paying countries from poorer ones.

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American Red Cross

Continued

The European Union and the WHO define a strategic resource as, “an economically important raw material subject to a higher risk of supply interruption.” Plasma fits this definition, and the PDMPs are critical products of this resource. The authors of this article make a considered plea that the current market-driven approach to the supply of plasma for further manufacture change from a market-driven approach to a public health-driven approach, and identify ways to move in that direction. The plasma industry should find ways to improve the production of source plasma.

Strengers PFW, Klein HG. Plasma is a strategic resource. Transfusion 2016; 56:3133-3137.

How do we monitor changes in transfusion-transmitted infections?

Blood collections in the United States are carried out through independent blood centers, either regional or centralized. All of them are not-for-profit, and the systems are highly regulated and certified/licensed by the U.S. Food and Drug Administration (FDA). Procedures are highly standardized throughout the system and vary little among organizations.

There is, however, no standardized system for the central reporting of much of the important data generated, for example trends in the tests that are done for infectious disease markers in the blood donor population. Monitoring of infectious disease markers is important, even more so now since the FDA now has amended requirements that previously deferred men who had sex with men (MSM) permanently. The amendment now requires deferment for 12 months after the contact. This guidance has been linked to the development of a monitoring system for infectious disease testing results from at least 50% of U.S. blood donors.

To accomplish this effort, the American Red Cross (ARC), Blood Systems, Inc. (BSI), and the New York Blood Center (NYBC) participated in this study as part of the National Heart, Lung, and Blood Institute’s Retrovirus Epidemiology Donor Study (REDS)-II. The three organizations compared and evaluated their testing systems, details of which can be found in the article. They developed data dictionaries and modified them all into a collective data dictionary. They agreed to definitions of positivity. Five files were developed based on the agreed-upon selections and definitions; one for demographics, and one each for tests for HIV 1 and 2, HBC, HCV and HTLV types 1 and 2. Blank or incomplete data files, as well as autologous files, were not included.

During the 2 year trial period (2011-2012), records for more than 14.8 million donations were collected. The overall frequency of positive donations (per 10,000) was HBV .757; HCV 2.007; HIV 0.202; and HTLV 0.337. As expected, women had significantly lower rates of infection except for HTLV. Frequencies of surveillance-positive results among repeat donors was much lower than with first-time donors. There are many useful pieces of information in the many graphs and tables of the article.

The requirement of the FDA was that the system represent at least more than half of the units of blood collected in any one year, or other period. The three organizations met this criterion with a common definition of a positive test result that was appropriate for monitoring across multiple blood systems. This pilot study demonstrates that data from several major collection organizations can be collected in a unified fashion and are of value for monitoring the ongoing safety of the U.S. blood supply.

Can we “Not Transfuse” our way to enough blood?

A lot of effort and about 15 well-planned and controlled trials over the last few years have resulted in a large decrease in the number of red blood cell transfusions in our hospitals, mostly in Europe and North America. Not only does this reduce a cost burden for hospitals, it also provides a bit of a cushion in that in many of these same countries it seems that people are living longer...although that’s not so clear in the United States, recently. Similarly, however, the birth rate in virtually all these countries has diminished, leading some to wonder from where the blood donors will be found to sustain transfusion needs in the near future.

When the Berlin Wall came down in 1989, and East Germany and West Germany were no longer divided, a fairly large exodus of young people left that formerly restricted area and emigrated to the west. The birth rate began to decline pretty rapidly in East Germany, to about 50% of what it had been, and this rapid change there presaged what happened about 10 years later in Western Germany and many other European countries. Physicians in Mecklenburg-West Pomerania, the most northeastern Federal German state, on the Polish border to the east, north of Berlin, and to the base of the Danish peninsula to the west, performed a study to address this question. They made some demographic measurements, and gathered baseline data in 2005, went back and gathered information and compared it to their projections in 2010, then published it in Transfusion in 2011. They have just completed the 2015 follow-up analysis for Transfusion in which they compared it with their projections in calendar year 2010.

Transfusion rates were measurably lower and blood donation rates were higher than predicted in 2005. The increase in donations in 2010, compared to the projections from 2005 seems to be partly due to the stimulating presence of a newly-established national blood service. Transfusion rates decreased in all age groups, but overall the transfusion rate increased to 66.4 red cells/1000 because of the absolute increase in the elderly population. Similarly, despite a very significant 7.4% decline in the donor age group, 18-65 y/o, whole blood donations increased by 11.7% between 2005 and 2010, but thereafter decreased by 21% (first time donors by 39.4%).

The large decline in birth rates in eastern Germany of more than 50% started in 1990 with German reunification. Thus, in 2008-2009, children born in 1990-1991 became 18 yrs. old and entered the eligible donor population. This makes the data on whole blood donations so important between 2010 and 2014. The number of first time donors declined substantially. Thus more donors will need to be recruited per 1000 population in the donor age group as the older age group grows more rapidly. As available donors decrease and elder patients increase, it is not clear that simply lowering Hgb thresholds that trigger transfusion will be enough to make up the difference. What lies ahead?

Improving red blood cell utilization using clinical decision support

In 2012 the American Board of Internal Medicine began what they called a Choosing Wisely campaign in which blood transfusion was found to be the most frequent and most frequently overused clinical therapeutic decision. The Joint Commission on Accreditation of Hospitals has thus promoted restrictive transfusion practices, performance indicators to curtail and restrict potentially injurious transfusions. Staff from the departments of Medicine and of Pathology at the Stanford University Medical Center have published (see reference) their experience using clinical decision support (CDS) to improve blood utilization by promoting more restrictive transfusion practices.

Many recent studies have demonstrated that transfusion is a poorly effective and sometimes harmful practice. Lower thresholds have been developed that have led to major decreases in blood transfusion and overall blood use. In most circumstances, other than massive transfusion therapy for massive trauma and blood loss, transfusion of red cells should be ordered and administered 1 unit at a time. In general, at least until quite recently, physicians are not very good at conforming to proven guidelines. The use of electronic medical records (EMR) now offers the ability to offer tailored feedback to the clinician at the critical time of order entry that helps to promote more appropriate use of blood products.

A review of CDS experiences showed that two-thirds of them were able to improve clinical practice and in systems including strict attention to the four key features of CDS, 94% of them made significant improvement. Other systems have used education coupled with computerized provider order entry to reduce inappropriate RBC transfusions. Limitations of the CDS approach include, but are not limited to: teams, not always individuals, may be invested with the decision-making; trainees may over-order; populations may be too small or too heterogenous for such an approach; there may be a lack of consensus development among staff.

Stanford implemented a CDS system in July, 2010, for red cell transfusions, in which a smart blood practice alert (BPA) is triggered when a provider orders RBCs for patients whose pre-transfusion Hgb is above a threshold of 7 g/dl for those with acute coronary syndrome or 8 g/dl for those with a post-cardiothoracic procedure. The article goes on to detail what is meant by “smart BPAs”. At the time of physician order entry, a BPA “interrupts” the computer order screen if the patient does not meet the developed criteria for red cell transfusion based on the best practice evidence agreed to by the institution’s committee. It’s important to recognize that the selection of a threshold Hgb level is intended to promote a review of the transfusion decision by the physician provider, not provide a suggested trigger for transfusion.

Use of such a CDS system has led to significant reductions in the use of red cells for transfusion at Stanford by 42% from 2009-2015. Hospital-wide mortality decreased significantly, as did 30-day readmission rates and length of stay. No adverse effects or events related to decreased use of red cell transfusions were noted. In addition, Stanford has seen an estimated $1.6 million in blood savings costs annually. Purchase costs represent only a fraction of the total costs of blood transfusion. The authors estimate savings of over $33 million over a 6 year period, not to mention greater patient safety.

Harmful effect of platelet transfusion in acute haemorrhagic stroke due to antiplatelet treatment

In addition to the rare (1 in a million) cases of congenital Factor V deficiency there are acquired cases thought to be mostly due to autoantibodies that arise spontaneously or from exposure to bovine thrombin used as a topical agent for hemostasis. It is thought that the bovine Factor V present with bovine thrombin causes the development of Factor V antibodies that cross-react with human Factor V. Factor V is primarily synthesized in the liver, but about 25% of circulating Factor V is stored in platelet alpha granules, which are released at sites of clot formation. Since this is an action specifically located at a bleeding site, some think that platelet transfusion is a more effective way to treat bleeding due to Factor V deficiency. HCV infection and antibiotic exposure have also been linked to autoantibody formation.

Physicians from the University of Texas’ Southwestern Medical Center in Dallas reported on three cases of Factor V deficiency, one congenital and two acquired, illustrating the need to identify specific etiologies to account for a low level of Factor V. The first case was that of a 30 y/o man who was known to be congenitally deficient in Factor V and whose bleeding problems had improved to some degree as he aged. He presented with a growing post-traumatic hematoma. He had generally been treated with platelet transfusions, and was again, this time with 5 units of platelets over 48 hours. His level was 1%, on admission and mixing studies showed no inhibition of Factor V in normal plasma.

The second patient had end-stage renal disease (hypertension) and was admitted with volume overload and pneumonia. She underwent dialysis and antibiotic therapy with piperacillin-tazobactam and vancomycin and was discharged on moxifloxacin. She returned shortly thereafter with volume overload. PT and PTT levels were normal, but blood cultures were positive for Enterobacter species. She went home with two weeks of ciprofloxacin, but returned again with persistence of right arm pain, which she noted on first admission but for which no cause was found by venogram. This time, her venogram showed a partial occlusion of the right brachiocephalic vein, and her PT and PTT were both prolonged. She was found to have a Factor V inhibitor. After steroid therapy, her clotting studies became normal and the venous occlusion was resolved.

The third patient was an elderly woman with Stage 3 chronic kidney disease who presented with pneumonia and shortness of breath and was treated with several antibiotics. Her PT and PTT were both prolonged, her Factor V level was less than 1% and a mixing study showed inhibition. She also responded to a short course of prednisone. The message here is that congenital V deficiency is pretty rare, and it’s important to rule out an acquired inhibitor, since the treatment for this is considerably different.

Blood and sex still matter

Every day in the United States, about 36,000 units of red blood cells, 7,000 units of platelets and 10,000 units of plasma are given to patients throughout the country. We are told that the risks of transmitting an HIV infection are 1 per 1.5 million; the risk for hepatitis C virus (HCV) is 1 per 1.1 million, and the risk for hepatitis B virus (HBV) is 282,000. If one excludes even simple febrile reactions—would that it were so easy, since they are no fun—the risk of simple, non-infectious reactions is getting close to 1 in 100. The fact is that none of the people who were injured in the attack on gay men in Orlando last June received blood from a man who has sex with men (MSM). Under current guidelines, they are not allowed to donate.

Not that they should have to. However, it seems somewhat ironic that the very measure that went so far towards making the blood supply free of HIV back in the 1980s keeps people from helping their friends get needed blood. People have been discussing this for some time, but it has now been brought very clearly to the attention of Congress.

The authors of this short paper, in addition to an accurate description of how we got here, note that the original ban on donation from MSM was from 1977 onward, and later was changed to 1985, the date we had a specific antibody test. Since then, many blood banks, but not all, have adopted the rule that prospective donors have had no MSM in the past 12 months. In December, 2015, following the lead of other countries and reviewing their experience, the FDA adopted the 12 month rule for MSM. Now with current HIV testing, the sensitivity for the DNA test is just shy of 100%, and in addition each sample is tested for HIV RNA, leaving a window period of 9-14 days.

The point of the paper is that maybe we need to apply the “risky sex” standard to all sexual encounters. Men who have had multiple female sexual partners of unknown HIV status should be considered at high risk, especially when compared to a monogamous gay couple who have given recently and tested negative.

Tranexamic acid is a procoagulant; it works by inhibiting clot breakdown

Is that good? This is a fine balance, you know, the Yin and Yang of hemostatic homeostasis. If the blood doesn’t clot, we could just run over into the outside world if we have a wound; if it just clots from a cut and doesn’t have something to stop it clotting, we’ll just congeal whenever we get hurt! The beauty of the mammalian coagulation/fibrinolytic system is that it enables us to be of and in the world and survive so many of its insults.

In an international study involving investigators from Australia, England, Quebec, New Zealand, Hong Kong, and Italy the utility of perioperative tranexamic acid in reducing the number of required transfused blood components was examined. It was a very complicated enrollment, starting with 17,735 patients undergoing coronary artery surgery being assessed. Sixty-five hundred were not eligible; 11,253 were eligible for the trial, almost 6600 declined consent. Forty-six hundred and sixty-two patients were enrolled and underwent randomization to 2 groups: 2311 underwent surgery with tranexamic acid administered; 2322 underwent surgery with saline instead, except for 32 who also received tranexamic acid.

The two groups were comparable in weight, age, sex (male), ASA physical status, left ventricular ejection fraction and New York Heart Association classification. Perioperative characteristics, such as pump time, heparin doses, cross-clamp times, duration of anesthesia, and duration of surgery were the same.

Death or thrombotic complications occurred within 30 days after surgery in 386 (16.7%) patients in the tranexamic acid group and in 420 (18.1%) of patients in the placebo group. Myocardial infarction (MI) was detected within the first 30 days in 269 patients (11.6%) in the tranexamic acid group and in 300 placebo-receiving patients (12.9%). The relative risk of an MI with tranexamic acid vs controls defined only by the third universal definition of MI was 0.84, with a p value of 0.045.

Patients in the tranexamic acid group all received significantly fewer units of each of the various blood components. Hemorrhage or tamponade leading to reoperation was twice as frequent in the control group. Reoperation led to more deaths and/or thrombotic complications. Postoperative seizures occurred in 15 patients treated with tranexamic acid, 0.7%, as opposed to 2 patients, 0.1% of the placebo group.

In summary, the authors found no evidence that tranexamic acid increases the risk of death and thrombotic complications after coronary artery surgery. The total number of units of blood products used was significantly less (p<0.001) in patients treated with tranexamic acid. Postoperative seizures occurred in 0.7% and 0.1% respectively in tranexamic acid vs placebo patients. There is some concern that seizures in such circumstances might be to thrombotic effects of the drug, and it is not clear if it is related to the dose of the medications used, More clarity is needed on this issue.

Massive transfusion strategies have been changing over the last couple of decades and massive transfusion protocols (MTPs) have been developed to guide and standardize “damage control” resuscitation. Early activation of an MTP is designed to deliver blood component ratios and other items to stem bleeding/blood loss more quickly, reducing mortality, maximizing blood product use, decreasing transfusion-related complications and making more effective and efficient use of blood products. In that regard, heterogeneity in such practices may be cause for some concern.

A survey of such practices in 2010 found this to be true. Since then, increasing use of thromboelastography and rotational thromboelastometry (TEG/ROTEM) based resuscitation, validated scoring systems, publication of the CRASH II trial supporting the use of tranexamic acid and point of care testing have influenced practice (see more on tranexamic acid in this issue.) Thus a 37 –question online survey was sent to members of the American Association for the Surgery of Trauma.

A total of 774 surveys were delivered by email to all AAST physician members. The email containing the survey link was opened by 344 members. A total of 193 members actually opened the link to the survey; thus, the detailed survey reached about 25% of the membership. A total of 191 surgeons from 125 institutions completed the survey. 123 institutions have an MTP; about half were new in the past 5 years. The number of coolers in use varied. Also highly variable were the numbers and ratios of red cells, plasma units and platelets utilized. Tranexamic acid is part of the MTP at 64% of the institutions. 26% continue to use (off label) recombinant activated Factor VII. MTP activation occurs more than 5 times/month at a third of the centers and 82% of the time for non-trauma patients. Point of care lab testing for PT, INR and PTT is used in 37% of the hospitals, but only 9% use TEG or ROTEM. Less than 10% of the institutions use a validated scoring system to activate MTP.

The authors feel that the results of their survey work show a lack of agreed upon, consistent practices underscoring the need for more outcome-based studies to standardize transfusion practices. Change is always hard, and demonstrating the utility of improving practices in emergent—sometimes frantically so—situations is a real test of our learning capacity.

It is exactly the middle of February. Here in the land of fir, pine, oak and maple we have just had a blizzard. It snowed 15” on Friday and Saturday, then the wind came up and blew that and another 8” all around the fields out back, and the nearby woods, and thoroughly covered the ice on the ponds. But life will go on; the snow will melt. The white-footed mice will crawl out of the shed, out of the now buried tufted field grass. The now-thawed *Ixodes scapularis* nymph ticks will have discarded their old anti-freeze-protected casings and gone looking for a new host: a mouse, a bird, a dog, a deer, a child, a gardener. And off we go again. In our backyard we have lots of deer and small mammals. We have babesiosis, Lyme disease, anaplasmosis, ehrlichiosis. We don’t have Powassan disease, yet, as far as we know.

*Babesia microti*, the causative organism for New England, the Northeast and the upper Midwest is the cause of most of the babesia-like illness seen in the U.S. Babesiosis became a notifiable disease in the United States in 2011 and was reported in 27 states by 2013. Most cases of it occurred in Connecticut, Massachusetts, Minnesota, New Jersey, New York, Rhode Island and Wisconsin. From 1979 through 2009 a total of 162 cases were reported, with 159 of them due to *B. microti*. As yet there is no FDA-licensed test for babesia infection.

From June, 2012 through September, 2014, the American Red Cross and Imugen Labs, in Norwood, Massachusetts carried out studies on 89,153 blood donation samples, representing 60,512 individual donors. They looked at arrayed fluorescence immunoassays (AFIAs) for *B. microti* DNA and real-time polymerase chain reaction (PCR) assays for *B. microti* DNA on blood donation samples from Connecticut, Massachusetts, Minnesota and Wisconsin. They determined parasite loads using quantitative PCR and infectivity by the inoculation of hamsters. Donors with test-reactive samples were followed. Using data on cases of transfusion-transmitted babesiosis, they compared the proportion of screened vs unscreened donations that were infectious.

Of the 89,000 + samples, 335 (0.38%) were found to be positive, of which 67 (20%) were PCR positive. Of the 9 donors who were PCR positive only 8 of them underwent seroconversion. The positive predictive value was 100% in PCR +, Ab - samples; in PCR+, Ab+ samples it was 98.5%. PCR+ samples were found all through the year, Ab- infections occurred from June through September. There was DNA clearance in 86% of the donors at 1 year, but there was also an 8% seroreversion rate. In Connecticut and Massachusetts there were no reported cases of transfusion-transmitted babesiosis from the 75,331 screened donations, as compared with 14 cases in the 253,000 unscreened donations.

It’s interesting to note that many of the hospitals asked for the screening to be continued after the study was completed. There are no data in the report that speak to the financial aspect of this for the hospitals and the blood center; however, one can imagine the discussion between the lawyers and the doctors on the responsible boards. Two years ago the FDA Blood Products Committee voted in favor of *B. microti* testing in all 50 states. Experience with the tests described here suggests that this combination provides a low false positive rate, perhaps 4 out of the 220,000 tests performed in this way. Even so, permanent deferral of donors, who may not be infectious at all, is hard to take. Some careful planning for implementation of such testing will be important.

Update on reimbursement for platelet safety measures

The Red Cross is committed to assisting its hospital partners in providing the safest possible products to partner hospitals. We also want to do all that we can to ensure that you are adequately reimbursed for the services you provide to patients. With this in mind, representatives of the Red Cross, America’s Blood Centers and AABB had a meeting in January of this year with decision makers at the Centers for Medicare and Medicaid Services (CMS) to discuss reimbursement related to CMS’s new reimbursement code P9072 which currently covers both rapid bacterial testing and pathogen reduction products and technologies. Our position is that the two are distinct with very different costs and although both should be reimbursed this should be through each having its own reimbursement code. The Red Cross will keep its hospitals informed as this situation evolves.

Publications Corner
Recent literature from Red Cross scientists and physicians

Miracles do happen: meeting the challenges of providing rare blood through the American Rare Donor Program. Flickinger C. Immunohematology. 2016 Jun; 32(2): 75-77.


Remember these websites:

- Immunohematology Journal redcross.org/immunohematology
- Reimbursement redcrossblood.org/hospitals/educational-resources/reimbursement
- SUCCESS® success.redcross.org

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